REMARKS

Claims 45-67 are pending in this application. Claims 1-44 have been cancelled and claims 45-67 have been added by this Amendment. Applicant reserves the right to reintroduce claims of original scope in a continuation or other related application.

Applicant has made minor corrections to the drawings and the specification as set forth above to provide mutual consistency and to update the specification with patent numbers of related applications.

In view of the foregoing, Applicant believes that all pending claims are allowable and respectfully requests a Notice of Allowance from the Examiner. Should the Examiner believe that a telephone conference would expedite the prosecution of this application, the undersigned can be reached at the telephone number set out below.

Respectfully submitted,

James R. Riegel
Reg. 36,651

San Jose, California
408-467-1900

MARKED-UP VERSION OF AMENDMENTS

In the Specification:

Insert the following paragraph on page 1, line 8:

This application is a continuation of U.S. Application No. 09/370,948, filed August 9, 1999, which is a continuation of U.S. Application No. 08/839,249, filed April 14, 1997, all of which are incorporated herein by reference.

Replace the paragraph starting on page 9, line 21, with:

Host computer system 12 preferably includes a host microprocessor 16, random access memory (RAM) [17] (not shown), read-only memory (ROM) [19] (not shown), input/output (I/O) electronics [21] (not shown), a clock 18, a display screen 20, and an audio output device 21. Host microprocessor 16 can include a variety of available microprocessors from Intel, AMD, Motorola, or other manufacturers. Microprocessor 16 can be single microprocessor chip, or can include multiple primary and/or co-processors. Microprocessor preferably retrieves and stores instructions and other necessary data from RAM [17] and ROM [19], as is well known to those skilled in the art. In the described embodiment, host computer system 12 can receive locative data or a sensor signal via a bus 24 from sensors of interface device 14 and other information. Microprocessor 16 can receive data from bus 24 using I/O electronics [21], and can use I/O electronics to control other peripheral devices. Host computer system 12 can also output a "force command" to interface device 14 via bus 24 to cause force feedback for the interface device.

Replace the paragraph starting on page 15, line 14, with:

FIGURE 2a is a top plan view and FIGURE 2b is a side elevational view of one embodiment of an interface apparatus including a mechanical apparatus 70 and user object 34, in which electromagnetic voice coil actuators are used to provide forces to the user object. Such voice coil actuators are described in greater detail in [co-pending patent application serial no. 08/560,091] U.S. Patent No. 5,805,140, hereby incorporated by reference herein in its entirety. Interface apparatus 70 provides two linear degrees of freedom to user object 34 so that the user can translate object [12] 34 in a planar workspace along the X axis, along the Y axis, or along both axes (diagonal movement). This embodiment is thus preferred for use with a mouse, puck, or similar user object 34 intended for such translatory motion. Apparatus 70 includes user object 34 and a board 72 that includes voice coil actuators 74a and 74b and guides 80.

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Replace the paragraph starting on page 15, line 24, with:

Object 34 is rigidly coupled to board 72. In the described embodiment, board 72 is a circuit board, for example, and which may be etched with conductive materials. Board 72 is positioned in a plane substantially parallel to the X-Y plane and floats, i.e., board 72 is not grounded. Board 72 may thus be translated along axis X and/or axis Y, shown by arrows 78a and 78b, and object [12] 34 is translated in the same directions, thus providing the object 34 with linear degrees of freedom. Board 72 is preferably guided by guides 80, which serve to keep board 72 substantially within a plane parallel to the X-Y plane and allow the board to translate in that plane, as shown by arrows [78] 78a and 78b. Board 72 is provided in a substantially right-angle orientation having one extended portion 82a at 90 degrees from the other extended portion 82b.

Replace the paragraph starting on page 17, line 14, with:

Gimbal mechanism 140 provides two rotary degrees of freedom to object 34. A gimbal device as shown in Figure 2 is described in greater detail in [co-pending patent applications serial nos. 08/374,288 and 08/400,233] U.S. Patent Nos. 5,731,804 and 5,767,839, both hereby incorporated by reference in their entirety. Gimbal mechanism 140 provides support for apparatus [160] 100 on grounded surface 142, such as a table top or similar surface. Gimbal mechanism 140 is a five-member linkage that includes a ground member 144, extension members 146a and 146b, and central members 148a and 148b. Gimbal mechanism 140 also includes capstan drive mechanisms 164.

Replace the paragraph starting on page 18, line 1, with:

Gimbal mechanism 140 is formed as a five member closed chain such that each end of one member is coupled to the end of a another member. Gimbal mechanism 140 provides two degrees of freedom to an object 34 positioned at or near to the center point P of rotation, where object 34 can be rotated about axis A and/or B. In alternate embodiments, object 34 can also be rotated or translated in other degrees of freedom, such as a linear degree of freedom along axis C or a rotary "spin" degree of freedom about axis C, and these additional degrees of freedom can be sensed and/or actuated. In addition, a capstan drive mechanism 164 can be coupled to each vertical member 168 to provide mechanical advantage without introducing friction and backlash to the system, and are described in greater detail in [co-pending patent application serial number 08/400,233] U.S. Patent No. 5,767,839.

Replace the paragraph starting on page 18, line 20, with:

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Other embodiments of interface apparatuses and transducers can also be used in interface device 14 to provide mechanical input/output for user object 34. For example, interface apparatuses which provide one or more linear degrees of freedom to user object 34 can be used. In addition, passive actuators having an amount of "play" can be provided to implement different reflex processes. Other embodiments of actuators and interfaces are described in [co-pending patent applications serial no. 08/400,233, Serial no. 08/489,068, Serial No. 08/560,091, 08,571,606, and Serial no. 08/709,012] U.S. Patent Nos. 5,767,839; 5,721,566; 5,805,140; 6,219,032; and 6,024,576, all hereby incorporated by reference herein.

Replace the paragraph starting on page 18, line 30, with:

In the host control loop of information, force commands 180 are provided from the host computer to the microprocessor 26 and reported data 182 is provided from the microprocessor 26 to the host computer. In one direction of the host control loop, force commands 180 are output from the host computer to microprocessor 26 and instruct the microprocessor to output a force having specified characteristics. Such characteristics may include the type of force desired, such as a vibration, texture, jolt, groove, obstruction, or other types of forces. Furthermore, the force commands may specify characteristics of the commanded force, such as magnitude, duration, frequency, conditions to cause the force to be applied, spatial range of force, etc. For example, in [co-pending patent application 08/566,282] U.S. Patent 5,734,373, a command protocol is disclosed in which a host command includes a command identifier, specifying the type of force, and one or more command parameters, specifying the characteristics of that type of force. In the preferred embodiment, the host computer can also provide other types of host commands to the microprocessor 26 besides force commands, e.g., commands to initiate and characterize the reading of sensor signals and the reporting of locative data derived from the sensor signals to the host computer from the microprocessor, commands to initiate and characterize the reading and reporting of button or other input device signals, etc.

Replace the paragraph starting on page 20, line 1, with:

In the local control loop of information, actuator signals 184 are provided from the microprocessor 26 to actuators 30 and sensor signals 186 are provided from the sensors 28 and other input devices 39 to the microprocessor 26. In one direction, the actuator signals 184 are provided from the microprocessor 26 to the actuators 30 to command the actuators to output a force or force sensation. The microprocessor 26, for example, can output the control signals in the form of a force waveform which is transformed into the appropriate form for the actuators by an actuator interface 38. Herein, the term "force sensation" refers to either a single force or a sequence of forces output by the actuators 30 which provide a sensation to the user. For example, vibrations, attractive forces, a single jolt, or a force "groove" are all considered force sensations. The microprocessor 26 can process inputted sensor signals to determine appropriate

output actuator signals by following instructions that may be stored in local memory 27 and includes force magnitudes, algorithms, or other data. The force process can command distinct force sensations, such as vibrations, textures, jolts, or even simulated interactions between displayed objects. These embodiments are described in greater detail in [co-pending applications 08/534,791 and 08/566,282] U.S. Patent Nos. 5,739,811 and 5,734,373, both incorporated by reference herein.

Replace the paragraph starting on page 22, line 21, with:

When using a mouse with force feedback functionality, different force sensations can be associated with different objects and/or functions in GUI 200. For example, certain objects such as icons 212 can have attractive or repulsive forces associated with them to attract or repulse cursor 202, where the user can feel such attractive or repulsive forces on user object 34. Slider 210 can have a ìgrooveî force associated with it to help maintain the cursor 202/user object 34 in the slider. The graphical objects can also have a simulated mass, friction, and/or inertia associated with them to provide characteristic forces when the objects are selected or moved using cursor 202. Many types of forces associated with GUI graphical objects are described in greater detail in [co-pending patent applications serial no. 08/571,606 and 08/756,745] U.S. Patent Nos. 6,219,032 and 5,825,308, both incorporated by reference herein.

Replace the paragraph starting on page 24, line 29, with:

Since the host computer is not displaying a user-controlled object in correlation with the position of the user object, a dichotomy is created between what is felt and what is visually perceived by the user, i.e., a break in the mapping between the position of the user object and the position of the controlled graphical object occurs: a decoupling of the input and outputs, as described above. This dichotomy between physical and visual experiences can be utilized to provide an illusion that no visual disturbance has occurred. Since users are greatly influenced by what they perceive visually, the user often does not notice that small deviations of his or her hand or other physical member in physical space does not exactly correlate with a corresponding visual component. A dichotomy related to this is described in detail in [co-pending patent application serial no. 08/664,086] U.S. Patent No. 6,028,593, which is hereby incorporated by reference herein. However, the dichotomy in the previous application dealt with "fooling" the user into believing that no movement of the physical object 34 was taking place by not moving the graphical object. Herein, it is desired for the user to feel and realize he or she is feeling a force sensation, but to reduce a visual disturbance associated with the sensation.

Replace the paragraph starting on page 26, line 34, with:

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An example of time lag is shown in the graph 234 of FIGURE 8, which illustrates a sensed waveform 236 input to the microprocessor in response to force waveform 218 output on user object 34 having substantially the same frequency and phase as the waveform 232. Time lag [234] 235 causes waveform 236 to be slightly out of phase with the input force waveform 218. Thus, when microprocessor 26 begins sampling the waveform 236 at the same time the force waveform 218 is output, the points E, F, G, and H are sampled. When the microprocessor reports points E, F, G, and H to the host computer 12, the host computer receives the square waveform 242 shown in the graph 240 of FIGURE 9 which is based on the reported data points. Waveform 242 has an amplitude of M, which may be small enough in some cases to cause the cursor 202 to only be moved a small amount and thus effectively reduce the disturbance.

Replace the paragraph starting on page 27, line 14, with:

The first method is illustrated in graph 244 of FIGURE 10 and causes the filter to report positions of the user object only at multiples of the period of the waveform 236. For example, the sensed waveform 236 of Figure 8 is shown as a dotted line, and point E is sampled at t = [T] 0, point G is sampled at point t = [2T] T, point I is sampled at point t = [3T] 2T, etc. The host computer thus receives a linear waveform 246 formed by these points which is offset from the baseline position 245 by the offset 248.

Replace the paragraph starting on page 30, line 31, with:

FIGURE 16 is an illustration of display screen 20 displaying GUI 200 and illustrates one use of the spatial disturbance filter. An icon 212 is displayed which may be selected by the user with cursor 202 to execute an associated program. In the described example, icon 212 has an attractive force associated with it, where cursor 202 and user object 34 are attracted to a center point P of the icon 212 when the cursor 202 and user object 34 are inside an attractive field perimeter 280. Other graphical objects can also be associated with such an attractive force, such as a button, item in a pull-down menu, a slider bar, a picture on a web page, a column in a spreadsheet, a line of text, or a single character of text in a document. The attractive force and its implementation is described in greater detail in [co-pending patent applications 08/571,606 and 08/747,841] U.S. Patent Nos. 6,219,032 and 5,959,613, both incorporated by reference herein. The user object 34 (e.g. mouse 214) is forced in a direction 284 by actuators 30, which causes cursor 202 to move in a direction 282 towards the center P of the icon 212. This attractive force is desired at this stage since it helps the user position the cursor 202 toward icon 212.

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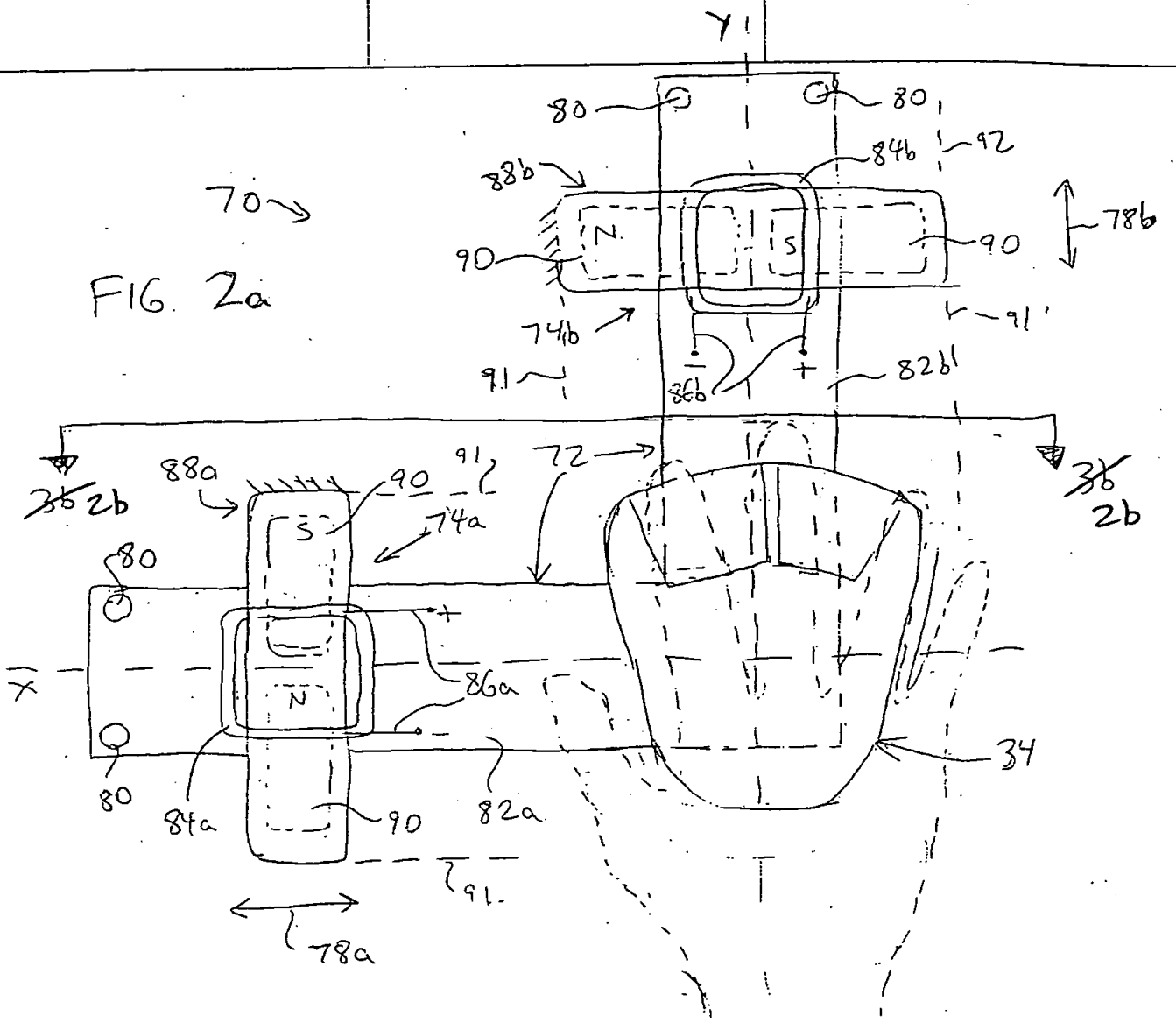
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92
88b
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90
90
78b
74b
91
91
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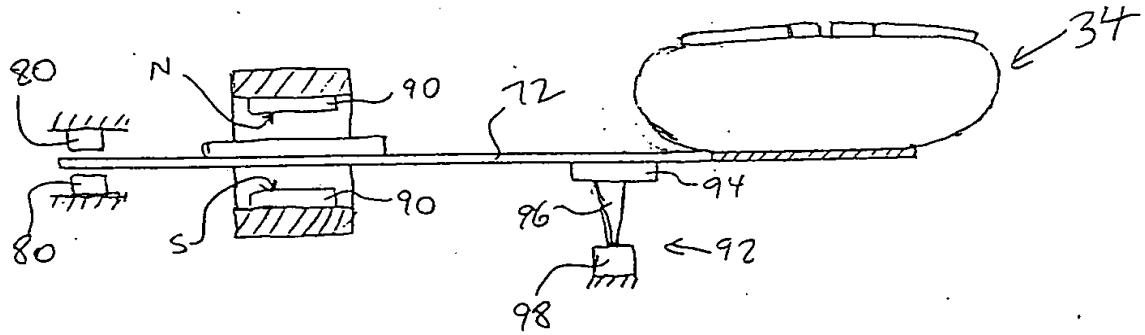
90
82a
34
78a

FIG. 2a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S
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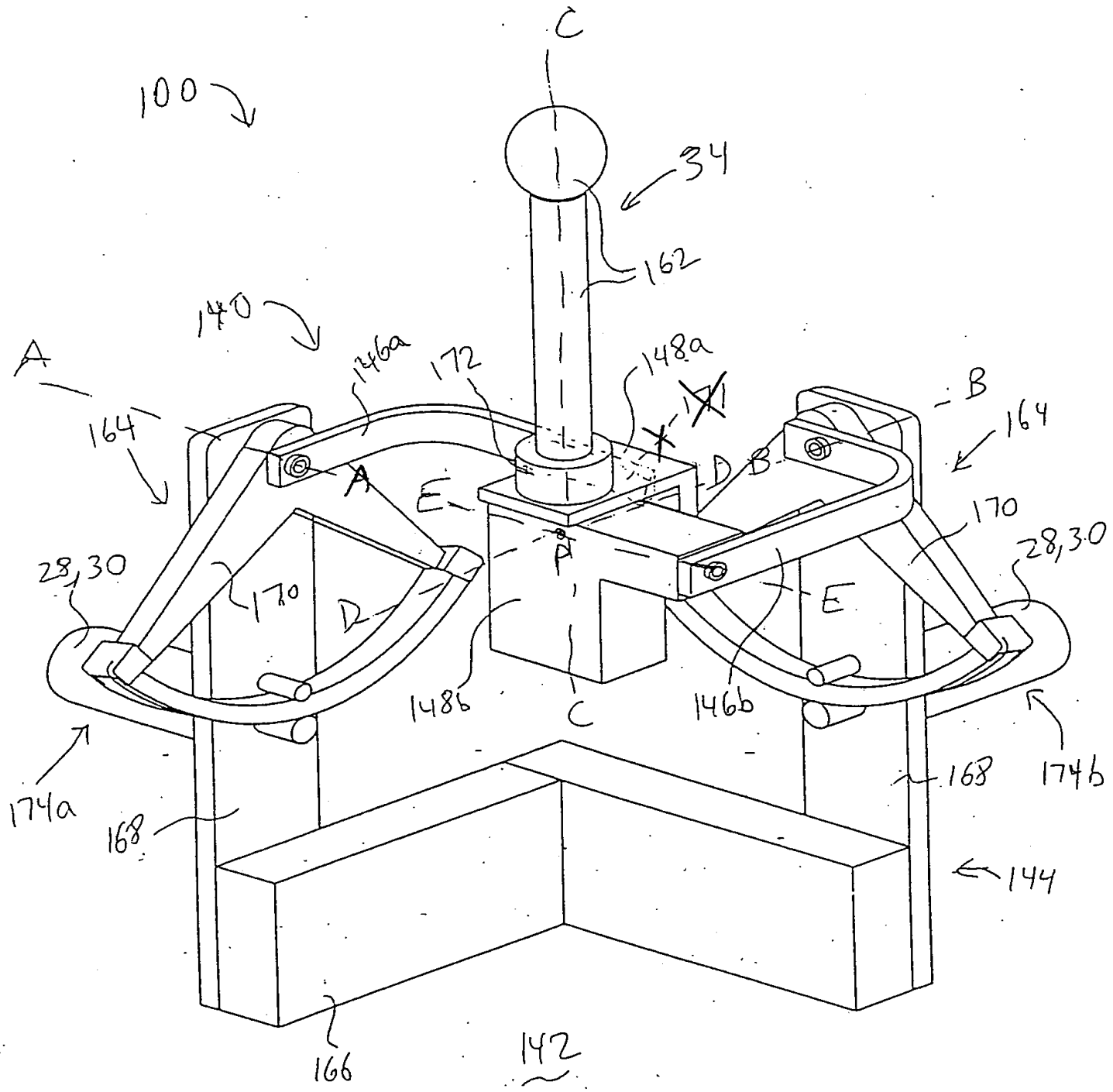
92
98

FIG. 2b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C
34
162
140
A
146a
172
148a
B
164
164
A
E
D
B
170
28,30
28,30
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D
E
148b
C
146b
174a
174b
168
168
144
166
142

Figure 3

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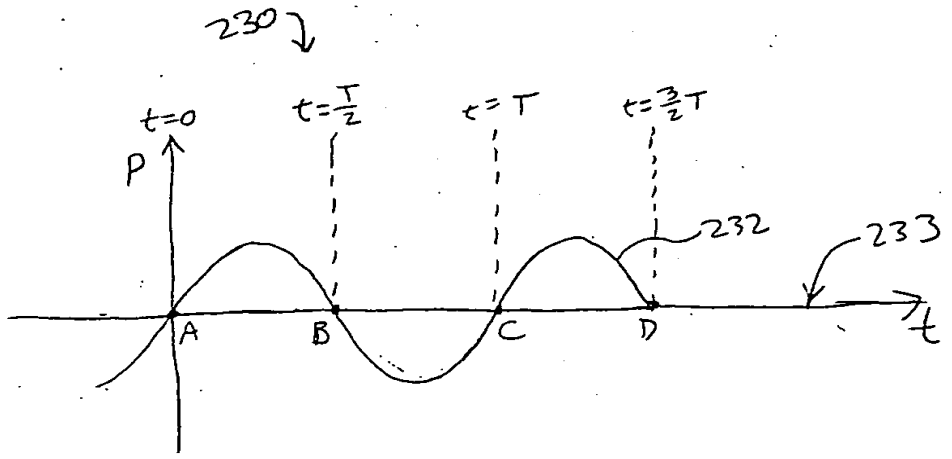

FIG. 7

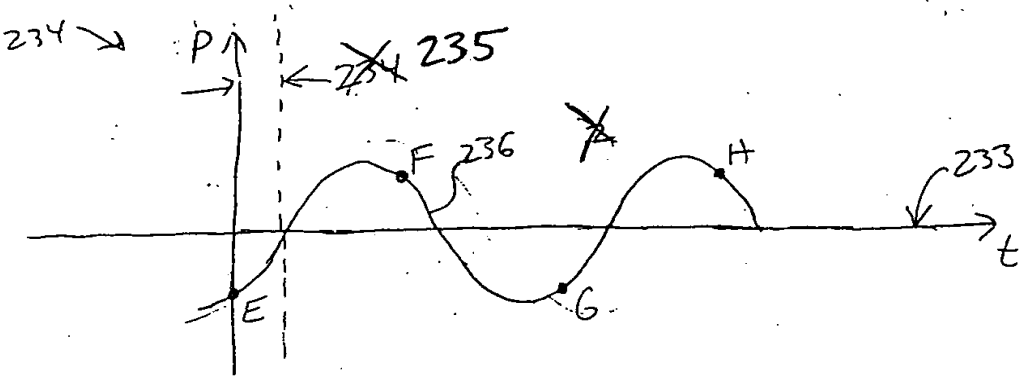

FIG. 8

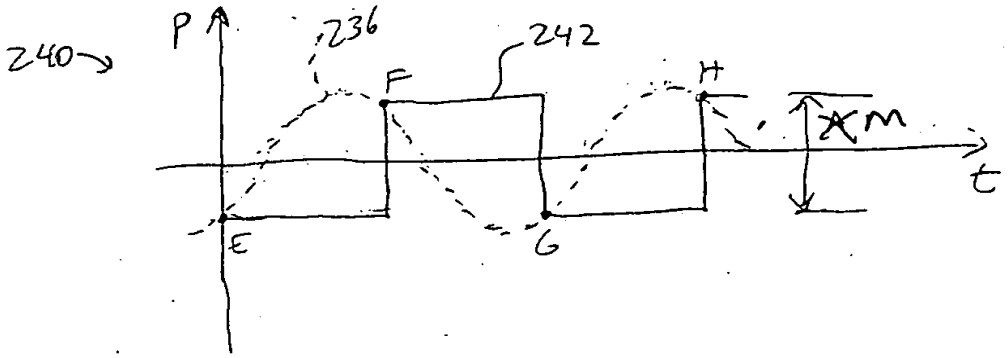

FIG. 9

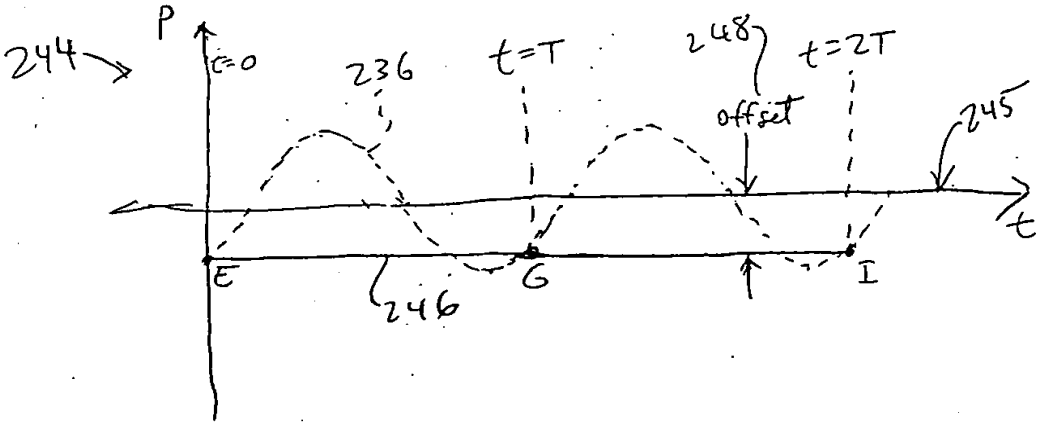

FIG. 10

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